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NATIONAL WEATHER SERVICE EASTERN REGION SUPPLEMENT 01-2004
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December 8, 2005

Operations and Services
Public Weather Services, NDS 10-5
Winter Weather Products Specification, NWSPD 10-513
Performance, NWSPD 10-16 Verification Procedures, NWSI 10-1601

WINTER STORM VERIFICATION IN EASTERN REGION

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SUMMARY OF REVISIONS: This supplement supersedes NDS Supplement 01-2004 dated January 15, 2004 and updates sections 4.4 (Event Definition), 4.8 (Lead Time), 4.10 (Expansion/Extension Rules) and Section 4.11 (Combined Events). Appendix B contains two new examples.

< Signed >   November 17, 2005

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Winter Storm Verification

1.   **Purpose.** The purpose of Winter Storm Watch/Warning verification is to assess NWS
        winter storm forecast performance and identify areas for service improvement.

2.   **Background.** Verification of winter storm watches and warnings can be done many
        ways. This supplement provides standardized guidelines so annual verification statistics
        can be compared.

3.   **Responsibility.** All Eastern Region (ER) Weather Forecast Offices (WFOs) are
        responsible for following these verification guidelines. ER Headquarters is responsible
        for compiling and posting summaries of seasonal statistics for WFO viewing.

4.   <u>**Guidelines.**</u>

    4.1   <u>**Verification Area.**</u> Verification for winter storm watches and warnings is based on individual public zones. Thus, a Winter Storm Warning (WSW) product covering three zones counts as three separate warnings.

    4.2   <u>**Winter Storm Verification.**</u> NWSI 10-513 discusses the multi-tiered concept for winter storm outlooks, watches, warnings and advisories. The only ER winter storm verification requirements are for watches and warnings. Winter Storm Watches will be verified on whether WARNING criteria were met, not advisory criteria. This maintains a one to one correspondence between watch and warning verification statistics.

    4.3   <u>**Issuance Trigger.**</u> Winter Storm Watches and Warnings for snow/ice accumulations are triggered when the <u>**mid-point**</u> of the forecast range is expected to meet or exceed the warning threshold. For watch issuance, a 50% or greater chance of reaching the threshold must exist; for warning issuance, 80% or greater.

    Watches and warnings may, on occasion, be triggered when significant public impact is expected, even though quantitative thresholds are not likely to be met. For watch issuance, a 50% or greater chance of significant public impact must exist; for warning issuance, 80% or greater.

    4.4   <u>**Event Definition.**</u> A winter storm event has occurred when the average* snow / ice accumulation across an entire zone equals or exceeds the warning threshold. For localized, mesoscale events (mainly lake effect snow bands), the average of representative observations within the localized band will be used to determine if the warning threshold was met and an event occurred, rather than the entire zone.

    Public impact from a storm can also be used to determine if an event has occurred. For example, if costly transportation impacts occur, especially from the the first snowstorm of the season, this can be counted as an event. Similarly, an early or late season storm causing widespread power outages from heavy, wet snow breaking leaf bearing tree branches onto power lines would count as an event because of the adverse public impact.

    For verification purposes, treat all winter storm, heavy snow, blizzard and ice storm warnings and events generically as winter storm warnings and events. For Storm Data purposes, enter events by the specific type of phenomena, whenever a predominant phenomena can be determined. See NWS Directive 10-1605 (Storm Data Preparation) for event definitions and additional details.

4.5 **Warned Event (Hit).** An event has been warned for when it occurs in a warned zone during the valid period of the warning. Watch hits are defined the same way.

4.6 **Warning without an event (False Alarm)**. A warning without an event occurs when an event fails to materialize within the warned zone during the valid period of the warning. Watch false alarms are defined the same way.

4.7 **Missed Events.** Missed events occur when:

a. the average[*] snow / ice accumulation found in a zone meets or exceeds the warning threshold when no warning was in effect, or
b. significant public impact occurs in a zone that would justify a warning when none was in effect,
c. warnings are downgraded to advisories, then warning criteria are subsequently met or exceeded during that storm, or
d. weather events continue beyond the end time of a warning, resulting in warning criteria being met once again (see Attachment B for an example).

4.8 **Lead Time.** Compute a lead time for each zone that experiences an event. Subtract the time of watch / warning issuance (WMO header line time stamp) from the time when the event first met warning criteria in the zone, or significant public impacts began. Set negative values to zero. If a zone experiences an event outside of the Valid Time Event Code (VTEC) window, assign that event a lead time of zero. Compute average lead time from all the lead times listed in the event database, including zeros.

4.9 **Percent of Events with Zero Lead Time.** Compute the percent of events with zero lead time by dividing the number of events with no lead time by the total number of events. Events with zero lead time include all missed events, plus warned events with no lead time.

4.10 **Expansion/Extension Rules.** Expansion of watches/warnings into new areas (zones) count as new watches/warnings, with lead times computed from the new issuance time in accordance with section 4.8. Extensions in time for zones already warned but not yet meeting warning criteria are counted as new warnings as well. If the initial warning and extension warning time windows overlap, and an event occurs within this overlap, lead time is computed from the initial warning issuance time. If the event happens outside the initial warning's time window but within the extension's time window, lead times are computed from the extension's issuance time, with the initial warning tallied as a false alarm.

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4.11 **Combined Events.** When winter storm and high wind events occur simultaneously, both phenomena should be mentioned within the WSW product. However, only the precipitation-related phenomena (observed amounts or public impact) will be used to verify the winter storm watch/warning.

When winter storm and non-precipitation type phenomena occur as discrete events, separate WSW and NPW products should be issued. WSWs are verified with precipitation-related phenomena while NPWs are verified with non-precipitation-related phenomena.

In cases where less than six hours of overlap is expected between WSW and NPW events (e.g. precipitation is winding down while winds are increasing or visa versa), separate WSW and NPW products should be issued, and verified as discrete events.

4.12 **Storm Episode.** A storm episode is defined as any storm system that produces phenomena reaching or exceeding warning criteria in one or more zones. Individual storm episodes may be generated by a single synoptic scale system, a series of waves along a slow moving frontal zone (frontal system counts as one episode), or a mesoscale event such as lake-effect snow.

4.13 **Verification Equations.** Equations for computing Probability of Detection (POD), False Alarm Ratio (FAR), Critical Success Index (CSI), Lead Time (LT) and Percent of Events with Zero LT (% 0 LT) are listed below:

$$POD = \frac{\text{\# of warned events}}{\text{total \# of events}}$$

$$FAR = \frac{\text{\# of warnings without an event}}{\text{total \# of warnings}}$$

$$CSI = \frac{\text{\# of warned events}}{(\text{\# of warnings without an event}) + (\text{total \# of events})}$$

$$LT = (\text{initial time criteria is reached}) - (\text{issuance time of warning})$$

$$\% \ 0 \ LT = \frac{((\text{\# of missed events}) + (\text{\# warned events with no lead time}))}{\text{total \# of events}} \times 100$$

These equations are applicable to watch verification statistics as well.

4.14   **Reporting Procedures.** Events occurring from October 1 through December 31 of any calendar year will be tallied for the entire CWA and reported to ERH MSD no later than the following January 31. A cumulative tally encompassing the period from October 1 to March 31 will be reported no later than April 30. Isolated late season storms between March 31 and May 31 must be reported no later than June 30. Any storms occurring the remainder of the fiscal year (through September 30) must be reported no later than October 15. Use Attachment A to summarize and report verification numbers to ERH.

4.15   **Verification Records.** Annual verification statistics should be kept on a zone by zone basis at each WFO to document and improve services on spatial scales smaller than the entire CWA. ERH will keep summaries of winter storm verification statistics for the entire region and make this information freely available for all WFOs to review.

[*] Average snow accumulation is computed using the arithmetic mean of all reports available within a zone. Sleet accumulation is considered the same as snow accumulation for verification purposes. Ice accumulation within a zone is computed using an arithmetic mean as well, however public impact is frequently used to determine the magnitude of an icing event, due to the difficulty of measuring ice accumulation.

Attachment A - Winter Storm Warning Verification Summary Sheet

WFO _____   Fiscal Year _____

Winter Storm Watches	OCT-DEC	OCT-MAR	OCT-SEP
Number of Watches Issued	_____	_____	_____
Watches with an event	_____	_____	_____
Watches without an event	_____	_____	_____
Probability of Detection	_____	_____	_____
False Alarm Ratio	_____	_____	_____
Critical Success Index	_____	_____	_____
Average (Event-based) Lead Time	_____	_____	_____
% 0 LT	_____	_____	_____

Winter Storm Warnings			
Number of Warnings Issued	_____	_____	_____
Warnings with an event	_____	_____	_____
Warnings without an event	_____	_____	_____
Probability of Detection	_____	_____	_____
False Alarm Ratio	_____	_____	_____
Critical Success Index	_____	_____	_____
Average (Event-based) Lead Time	_____	_____	_____
% 0 LT	_____	_____	_____

Winter Storm Event Summary			
Number of Events	_____	_____	_____
Events Watches Only	_____	_____	_____
Events Warnings Only	_____	_____	_____
Events Neither	_____	_____	_____
Events Both	_____	_____	_____
Total # of Storm Episodes	_____	_____	_____

POD = $\dfrac{\text{\# of warned events}}{\text{total \# of events}}$ FAR = $\dfrac{\text{\# of warnings without an event}}{\text{total \# of warnings}}$

CSI = $\dfrac{\text{\# of warned events}}{(\text{\# of warnings without an event}) + (\text{total \# of events})}$

LT = (initial time criteria is reached) - (issuance time of warning)

% 0 LT = $\dfrac{((\text{\# of missed events}) + (\text{\# of warned events with no lead time}))}{\text{total \# of events}}$ x 100

Attachment B - Verification Examples

Example 1 - reference section 4.7.c - Missed Events.

The mid-shift issues a winter storm warning for Franklin County valid from 6 PM to 6 AM. At 3 PM, the day-shift decides to downgrade the warning to an advisory. Then at 3 AM, 3 inches of snow accumulates, meeting warning criteria. This scenario is tallied as both a missed event and a false alarm. The double penalty is designed to encourage forecasters to be conservative about downgrading warnings.
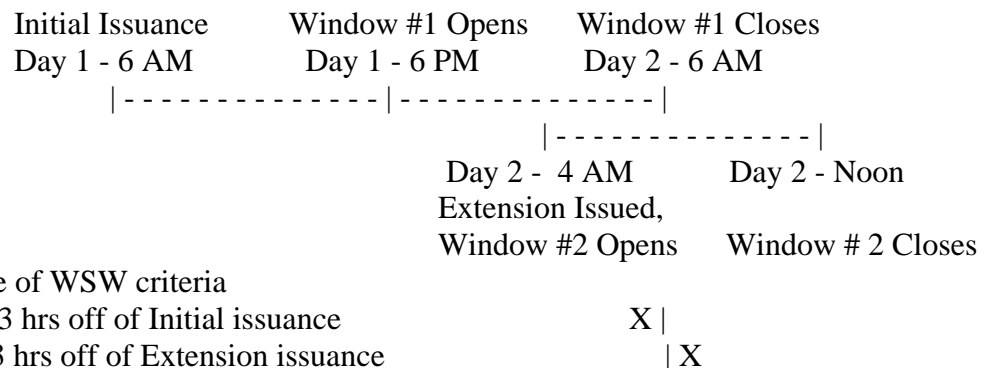
Example 2 - reference section 4.7.d - Missed Events.

A foot of lake-effect snow has fallen in Franklin County, but the warning covering this event is allowed to expire at 5 PM, as the snow band is forecast to drift south of the county. The band does drift south, but more slowly than expected. An additional, criteria-meeting 7 inches of snow falls after 5 PM. This is counted as a missed event, because the warning threshold was re-met outside of the warning time window.

Example 3 – reference section 4.10 – Extension Rules.

The mid-shift issues a winter storm warning for Franklin County with a VTEC event valid time from 6 PM that night to 6 AM the next morning. At 4 AM the next morning, it is snowing, but warning criteria have not yet been met. An extension is issued at 4 AM for the warning to continue until noon. At 7 AM warning criteria are met. The initial warning is tallied as a false alarm. The extension is counted as a hit, with a lead time of 3 hours.

If the storm meets or exceeds WSW criteria during the warning overlap time (say 5 AM), a lead time of 23 hours would be computed off of the initial warning (5 AM of day 2 minus 6 AM of day 1 = 23 hours). Graphically, the cases look like this:

```
           Initial Issuance      Window #1 Opens     Window #1 Closes
           Day 1 - 6 AM          Day 1 - 6 PM         Day 2 - 6 AM
               |- - - - - - - - - - - - - -|- - - - - - - - - - - - - -|
                                         |- - - - - - - - - - - - - -|
                                          Day 2 -  4 AM        Day 2 - Noon
                                          Extension Issued,
                                          Window #2 Opens     Window # 2 Closes

X = first occurrence of WSW criteria
5 AM Event LT =23 hrs off of Initial issuance                    X|
7 AM Event LT = 3 hrs off of Extension issuance                  |X
```

Example 4 – reference section 4.11 – Combined Events.

A winter storm with significant snow accumulation is winding down, but winds behind the storm system are increasing and are expected to reach wind warning criteria a few hours before the snow ends, then continue another 12 hours after that. An NPW should be issued before the WSW expires to address the wind situation. The WSW will be verified based on snow accumulation; the NPW will be verified separately based on high wind or wind damage reports.

Example 5 - reference section 4.12 - Seasonal Lead Time computation.

Seasonal lead time computations must use a weighted average of each storm's lead time rather than a simple average. Thus, an office with two storms will have:

((20 zones x 12 hr) + (36 zones x 16 hr)) / 56 zones, yielding the correct LT of 14.57 hours, rather than a simple average of (12 hr + 16 hr) / 2, which gives an incorrect LT of 14 hours.

Alternatively, each individual event lead time through the whole season can be used to compute the average lead time.